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PULSE-TYPE REGULATED HIGH VOLTAGE SUPPLY FOR GM TUBES

by

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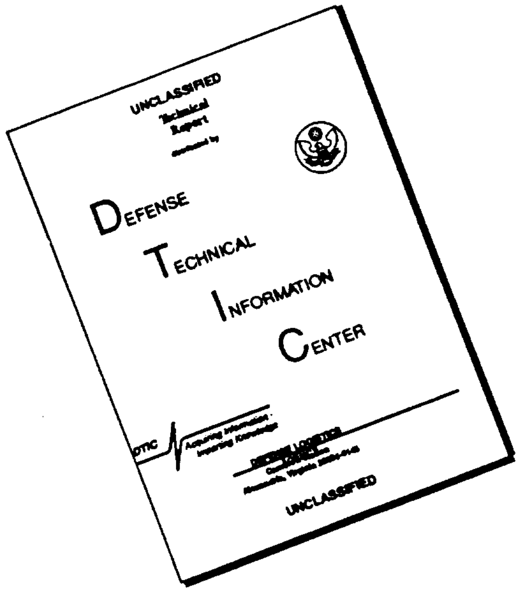

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Abstract

A Pulse Type 1000 volt Variable High Voltage Supply is described. This supply utilizes a 6BG6 tube to interrupt the current through a standard inductance. Rectification is by means of a CK1013 cold cathode rectifier which eliminates a well insulated filament transformer. The output is shunt regulated by means of a 2C53 tube. An advantage of these supplies is the small size 5" x 5" x 6" and the economy in cost. Standard parts are used throughout. Ripple at 1000 volts is 80 millivolts. Regulation curves are given.

Introduction

Despite the wide use of G-M tubes there is as yet to the author's knowledge no variable regulated high voltage supply commercially available suitable for incorporating in a chassis with other equipment. The use of commercial R-F equipment entails the necessity for adding additional regulation, or if a regulated supply is used the equipment is in general too large to permit room for other components on the chassis. The following instrument is an attempt to rectify these difficulties. A paramount consideration is reliability since G-M tubes are often operated for many hours consecutively.

Circuit

The Pulse Type High Voltage Supply has been investigated in a very adequate manner by Siezen and Kerkhof.[1] These supplies are based upon the periodic interruption of current through an inductance L. Assuming that this inductance is shunted by a stray capacitance Cp, the peak voltage V_m of the transient oscillation caused by the interruption can be deduced from the energy equation

$$\frac{1}{2} L i_m^2 = \frac{1}{2} C_p V_m^2$$

hence.

$$V_m = i_m \sqrt{\frac{L}{cp}}$$

Thus, if i_m = 12 milliamperes L = 50 henrys

C_p = 50 micromicrofarads V_m = 12 kilovolts

1. G. J. Siezen and F. Kerkhof, Proc. I.R.E. 36, 401 (1948).

The advantages of this type of supply can be enumerated as follows:

1. The interruption frequency can be made high enough so that there can be a substantial reduction in the size of the filter.
2. The frequency can be made low enough so that no interference is generated.
3. The inductance L may be small enough so that stray magnetic fields are eliminated.
4. Insulation requirements on the A. C. side are less severe because of the transient nature of the oscillations.
5. V_m is a function of i_m hence V_m can be adjusted by varying the bias.
6. The high voltage generation by a tube limits the output. Hence, the output may be shorted with no injury to the circuit.

Figure 1 is a schematic of the circuit used. A multivibrator has been chosen for the repetition frequency although a blocking oscillator or other means could have been used. This was done in the interest of economy. The repetition frequency was measured to be 200 c.p.s. By means of a Tektronix oscilloscope the usual multivibrator wave pattern was observed. The wave shape on the grid of the 6BG6 showed a 170 volt drop in two microseconds followed by an exponential rise of 100 volts in about 2.5 milliseconds followed by a square wave of about 2.5 milliseconds duration. It is necessary to place a large negative voltage on the grid of the cut-off tube in order that it does not conduct during the time the large transient voltage is on the anode.

In order to eliminate the need for a well insulated filament transformer for the rectifier a cold cathode high voltage rectifier was used. If voltages higher than 1200 volts are needed, it is necessary to replace this cold-cathode rectifier with an 8016. This combined with a change in bias on the 6BG6 permits a 3 kilovolt output provided the Stancor C1003 choke is immersed in transformer oil.

Regulation is obtained in the conventional manner by means of a 2C53 tube shunt regulator. At 1000 volts output the drop across the anode load of this regulator is 500 volts.

To obtain a variable output voltage the bias on the cathode of the 2C53 tube is varied. This bias is obtained from the 300 volt supply. The control for this bias plus the 0-50 microammeter is mounted on the front panel of the associated equipment.

Performance

Photographs 1, 2, 3 illustrate the manner in which this supply is laid out. The performance of the instrument will depend to some extent on the supply voltage used with it. The curves in Figure 2 were taken with a Model 50 supply. This supply is similar to the circuit described by Higinbotham, Gallagher and Sands[2] with the exception that more current output is provided.

To obtain some idea of the regulation the following method was used. By means of a variac the line voltage input to the low voltage power supply

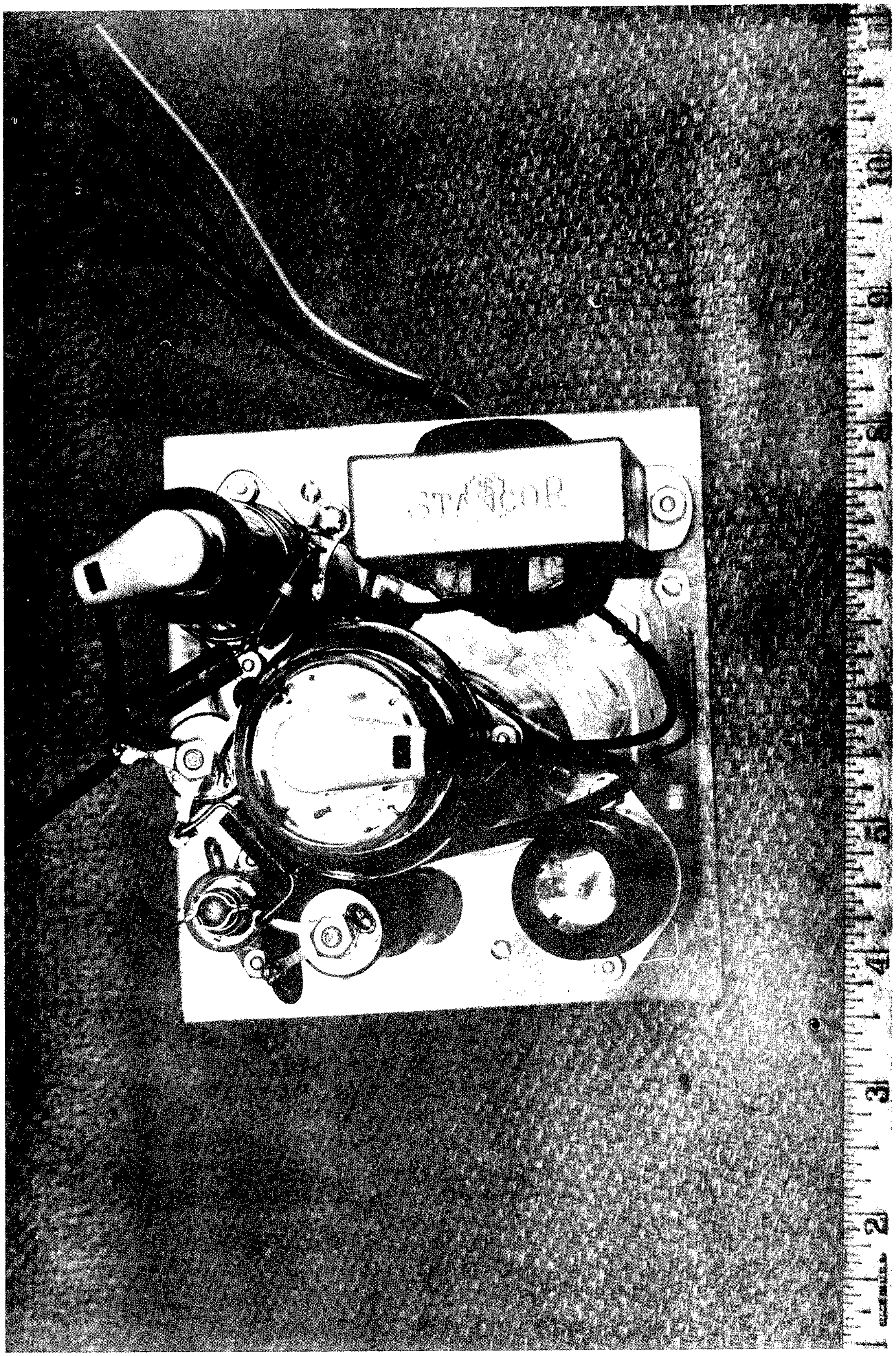
2. W.A. Higinbotham, J.D. Gallagher, and M. Sands, Rev. Sci.Inst. 18, 714 (1947).

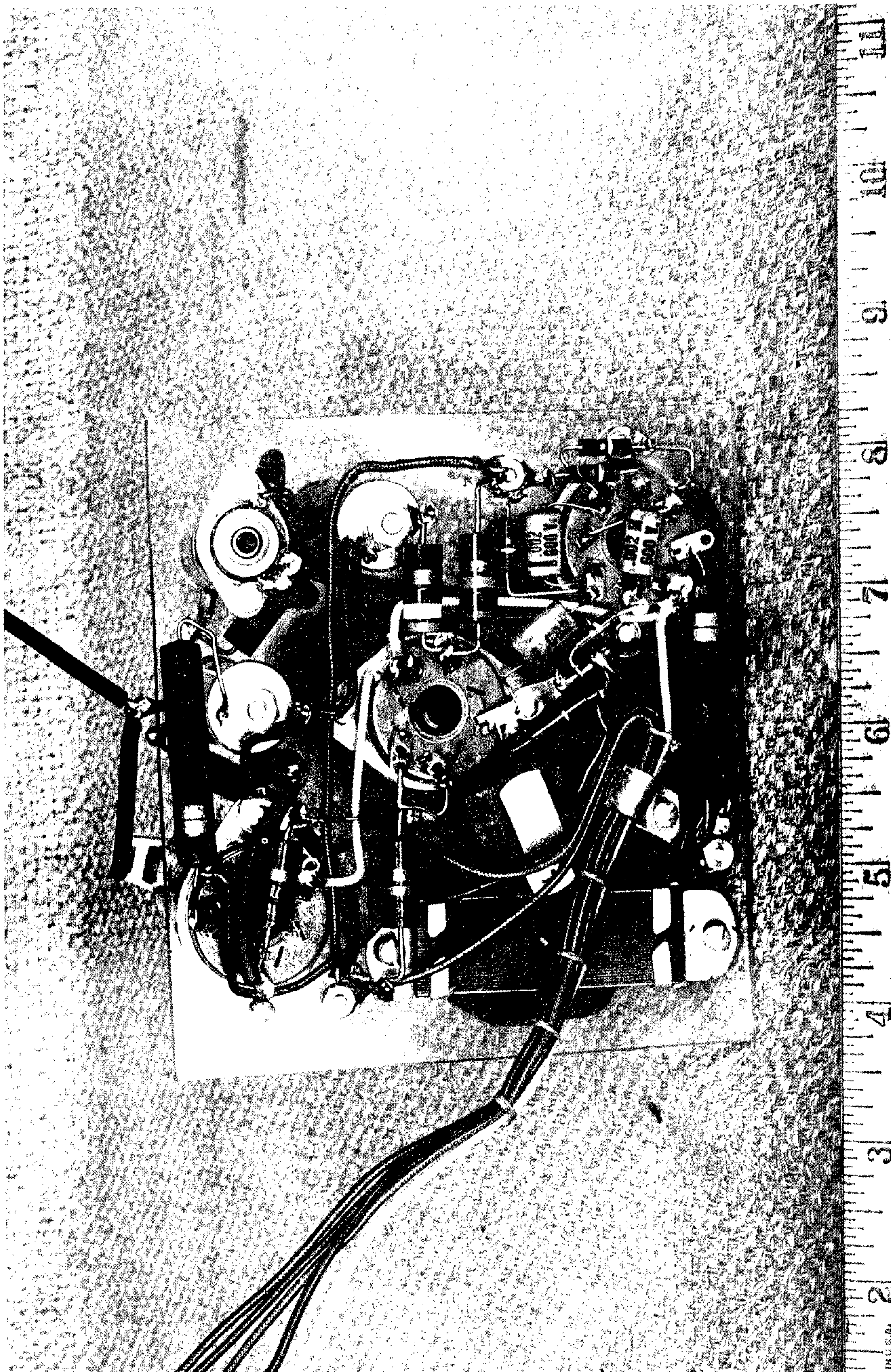
was set at 80 volts ac. The output of the high voltage supply was set at 800 volts. 800 volts of bucking batteries were then employed so that a general radio 728-A high impedance voltmeter could be set on the 10 volt scale. The line voltage was then varied in steps of 5 volts and the change in the voltmeter reading was noted. The process was repeated at 900, 1,000 and 1,100 volts. This information is plotted in Figure 2. It will be noted that the supply is stabilized to 0.1% change in output D.C. voltage per ten percent change in the line at 115 volts ac. Of course, this good performance should be attributed to the well regulated low voltage supply. However, since this supply is one commonly used with scaling circuits the results are germane.

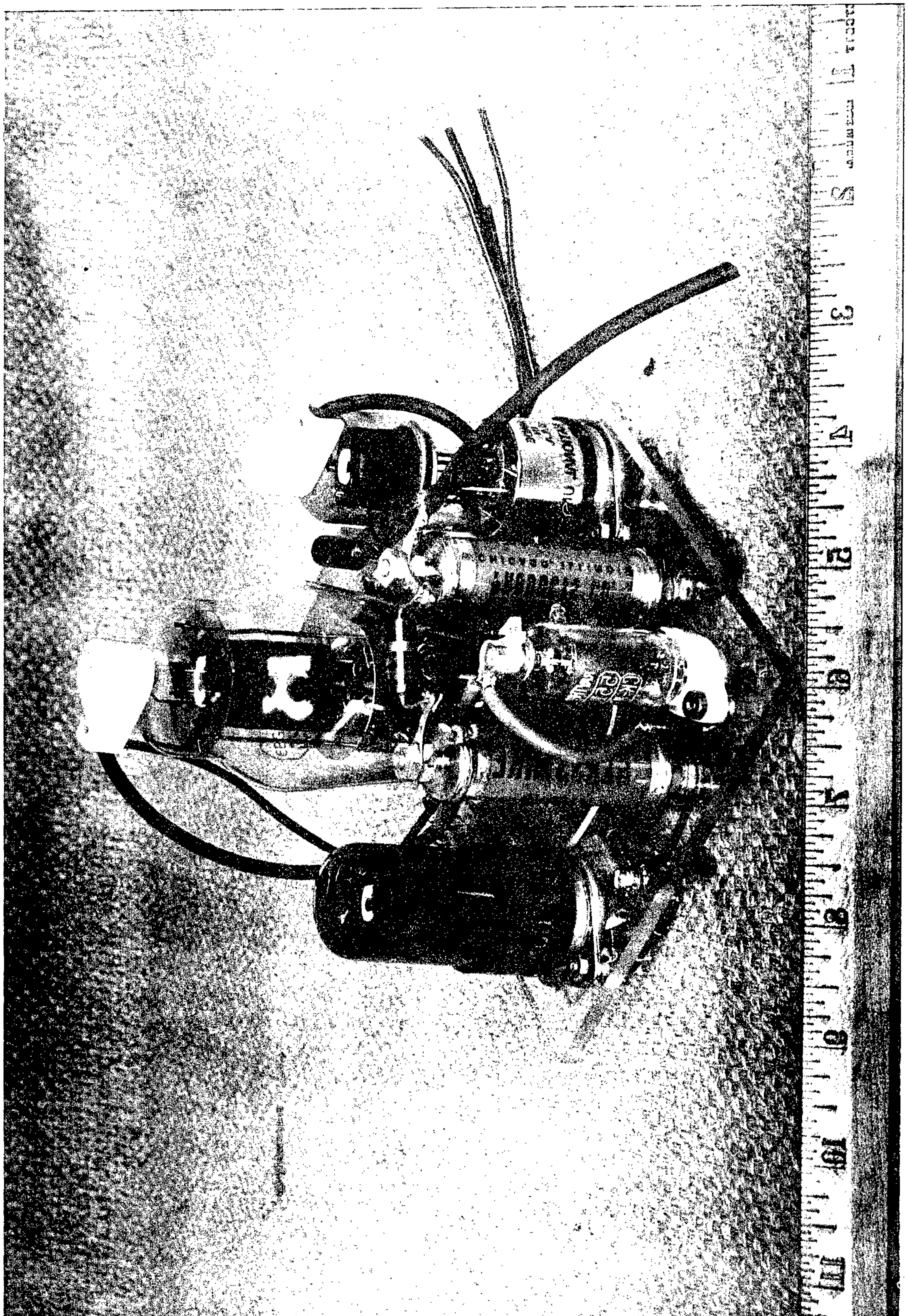
To improve reliability and insure long life it should be noted that all the filament voltages have been reduced by means of resistors. The filament supply is 6.3 volt ac taken from the associated low voltage supply. The efficiency of the supply is not good, being of the order of 4%. However, since G-M tubes require very small currents (usually less than 3 microamperes) the efficiency is relatively unimportant since one can afford to waste power provided the input power is not a serious drain on the low voltage supply.

The input power in this case is 3.6 watts or 300 volts at 12 milliamperes. Since this is easily furnished by most supplies used in conjunction with this circuit no attempts were made to improve the efficiency.

Ten of these circuits have been built and operated continuously for six months with no failures from any cause whatever. Output ripple voltage is about 80 millivolts as measured with a Ballantine Model 300 voltmeter. This was considered sufficient for the purpose in hand. However, this value can be reduced by inserting an appropriate condenser between the plate and the grid of the 2053.







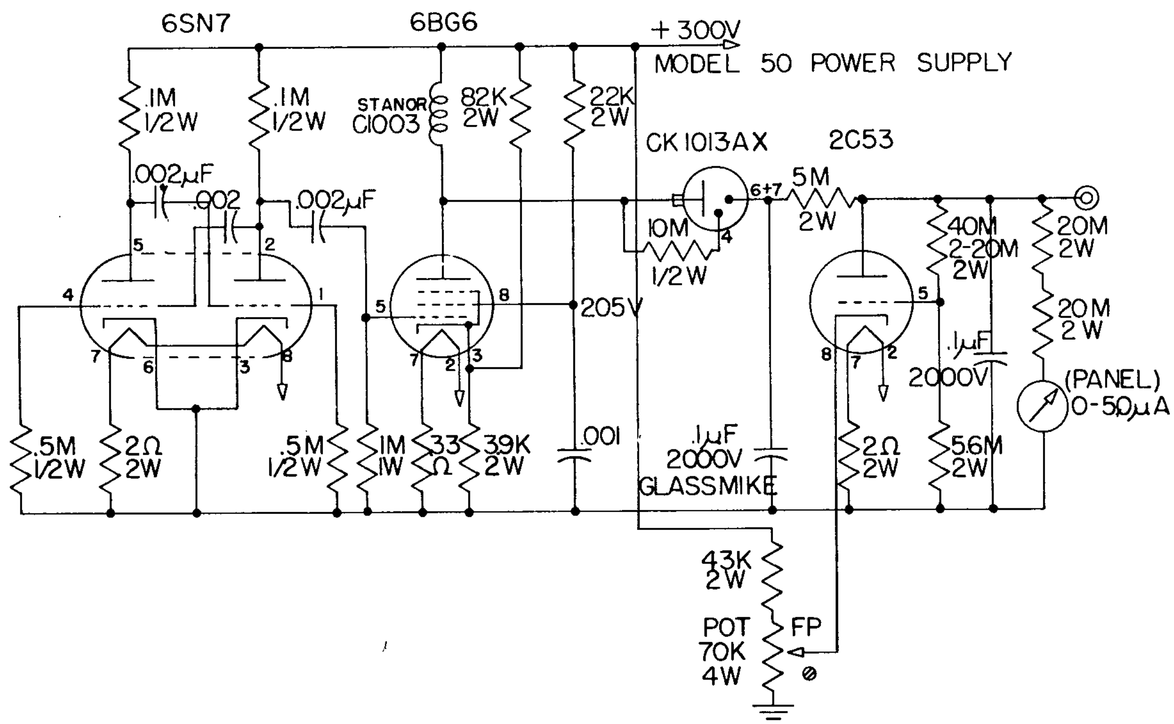

6SN7
6BG6
+300V
MODEL 50 POWER SUPPLY
.1M
1/2W
.1M
1/2W
STANOR
C1003
82K
2W
22K
2W
CK1013AX
2C53
.002μF
.002
.002μF
5M
2W
10M
1/2W
205V
40M
2-20M
2W
20M
2W
20M
2W
.1μF
2000V
(PANEL)
0-50μA
.5M
1/2W
2Ω
2W
.5M
1/2W
1M
1W
33
Ω
39K
2W
.001
.1μF
2000V
GLASSMIKE
2Ω
2W
56M
2W
43K
2W
POT
70K
4W
FP

FIGURE NO 1

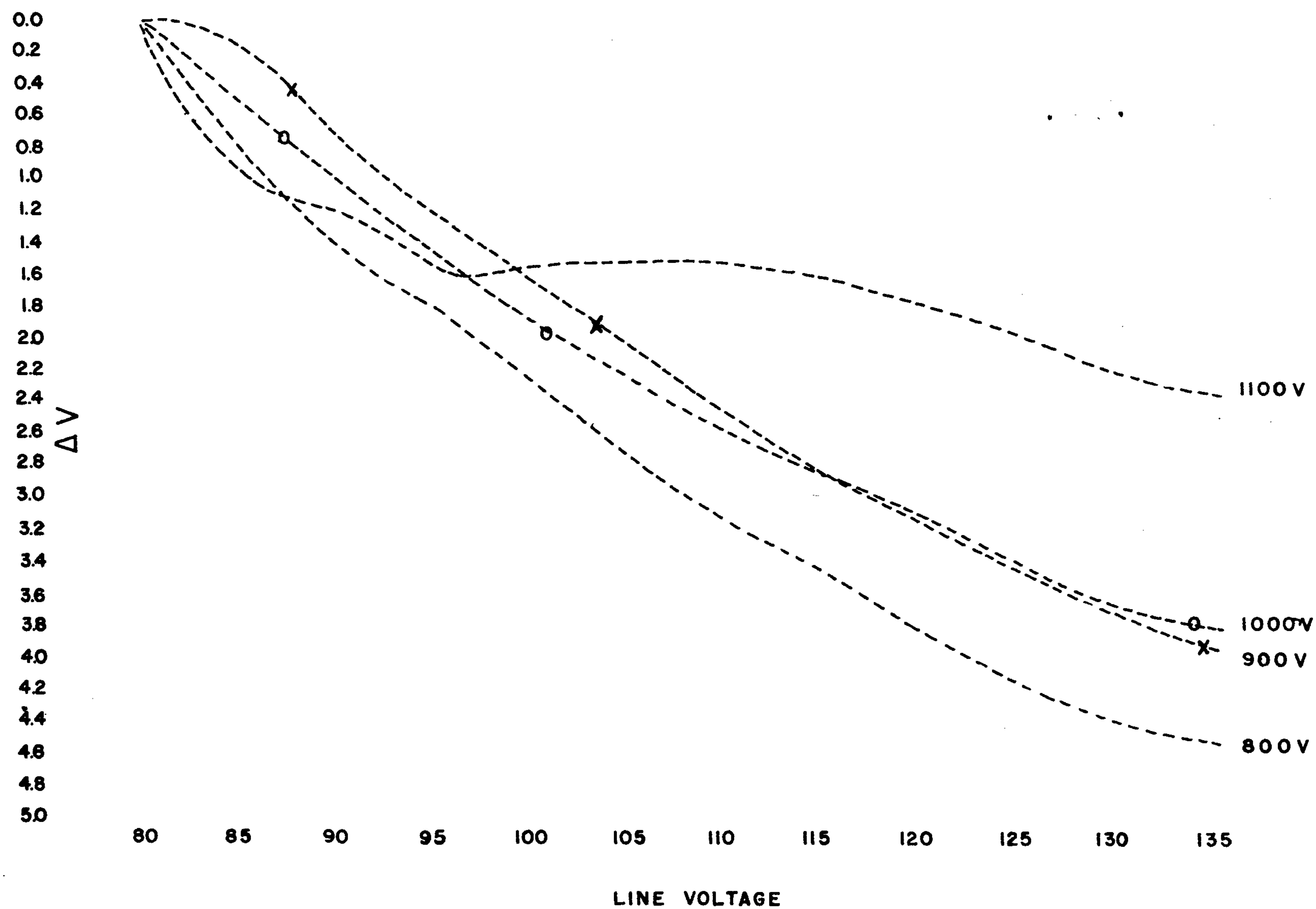

0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
3.2
3.4
3.6
3.8
4.0
4.2
4.4
4.6
4.8
5.0
ΔV
80
85
90
95
100
105
110
115
120
125
130
135
1100 V
1000 V
900 V
800 V
LINE VOLTAGE

FIG.2